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39TH ANNUAL CONFERENCE REPORT ON COTTON INSECT RESEARCH AND CONTROL

E. G. King, J. R. Phillips, and R. B. Head
Research Entomologist, Professor, and Extension Entomologist, respectively
Southern Field Crop Insect Management Laboratory
USDA, ARS, Stoneville, MS 38776;
Entomology Department, University of Arkansas
Fayetteville, AR 72701; and
Mississippi Cooperative Extension Service
Mississippi State University, MS 39762, respectively

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Foreword

This is the second annual report under the new format approved by conferees in 1984 for reporting the proceedings of the Cotton-Insect Research and Control Conference. In this format, the annual report will be limited to: 1) a summary of the 1985 insect and crop conditions by state; 2) a revised insect losses statement; 3) changes in pesticide registrations; (4) insect control recommendations since the most recent full report (37th Annual Conference Report on Cotton-Insect Research and Control published in 1984); 5) a listing of promising new pesticides,; and 6) a brief summary of significant research accomplishments and progress in on-going research projects by state and federal organizations. The information contained in this report is taken entirely from summary statements submitted by representatives of state and federal research or extension organizations across the U.S. cotton belt.

Crop and Arthropod Pest Conditions

Alabama. Thrips population densities were high and foliar applications of insecticides were required for their control even where systemics (except aldicarb at 0.4 lb AI/acre) were applied. Plant bug populations occurred at moderately high levels with much of the damage apparently caused by adults moving into cotton. Boll weevils, *Anthonomus grandis* Boheman, were more numerous and damaging than expected, especially in the non-traditional weevil areas of the state, such as the Tennessee Valley. *Heliothis* populations were about average in density. However, isolated areas of high tobacco budworm, *H. virescens* (F.), pressure were observed in June and early July. Fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), numbers were greater in some areas than previously observed. These populations occurred earlier in the season (early July) and were more damaging than populations of other lepidopteran species. Control of FAW populations with insecticides gave erratic results. Other insect pests, such as spider mites, whiteflies, and western flower thrips (*Frankliniella occidentalis* Pergandie) were present, but were not a serious problem. Flea beetles (*Systena* spp.) did occur at damaging levels on some seedling cotton,while the European corn borer, *Ostrinia nubilalis* (Hübner), was reported in two counties.

Arkansas. The overall growing conditions in 1983 were excellent with a warm spring that resulted in good stands. Populations of thrips were heavy in most areas and foliar sprays were required in fields where in-furrow systemic insecticides had not been used. The cotton fruited rapidly and set early in most areas. Dry weather concerned many growers in some areas.

The bollworm population in southeastern Arkansas was light to moderate with egg populations in August ranging from low to around 18,000 per acre. The community insect management programs contributed significantly to overall bollworm control by reducing populations to low levels. In northeast Arkansas, bollworm populations were low.

Plant bug populations were high in several areas, though not widely distributed. Many growers applied insecticides for control of plant bugs, particularly in northeastern Arkansas. Aphid populations were higher than usual and numerous fields were treated. Spider mites occurred in a few fields, but populations were scattered and not a major consideration in insect control.

California. In the San Joaquin Valley insect/spider mite problems were negligible. Fewer pesticide applications were made for *Lygus* bug/spider mite control than normal. Thrips, primarily the western flower thrips, were abnormally abundant on many crops throughout the state, but were not an overriding problem in cotton. Where insecticides were applied for thrips control, populations of spider mites (several species) were potentiated. The bollworm was probably more serious than either *Lygus* bugs or spider mites; regardless, the loss was less than 1%.

The cotton planting season was generally very favorable followed by unusually cool weather, resulting in some stand reduction. This was followed by an unusually warm June and July which resulted in an excellent crop set in a brief period of time. August and September were record breaking cool months and many fields suffered severe infections of Verticillium wilt. Generally, this occurred late enough in the season to minimize impact on crop yield. The result is that an average yield slightly above the 1,110 lb/acre estimate was expected. Localized infestations of spider mites [strawberry spider mite (*Tetranychus turkestani* Ugarov and Nikolski), two-spotted spider mite (*T. urticae* Koch), Pacific spider mite (*T. pacificus* McGregor)], *Lygus* bugs (*Lygus hesperus* Knight) and beet armyworm [*Spodoptera exigua* (Hübner)], occurred throughout the valley but were not a general problem. Scattered infestations of cotton aphid were noted by many farmers and persisted throughout the summer with some severe infestations during late summer and fall. Generally, these were controlled by parasites in the later part of the summer. The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), was locally abundant in the southern portion of the San Joaquin Valley.

Louisiana. Insect control was acceptable, but yield potential was curbed by an extended, early season drought followed by late season rains. In early season, thrips population pressure was ca. normal and plant bug (a complex) populations were generally moderate. Cotton fleahoppers, *Pseudatomoscelis seriatus* Reuter, were more numerous than in recent years. This species comprised a higher percentage of the total plant bug population, especially in the northeast.

Catches of overwintered boll weevils in pheromone traps were low, and early season field infestations were generally light. However, populations increased to economic proportions by the second (F_2) field generation, and the pest was a late-season problem in fields that were not well managed.

In general, *Heliothis* populations were light in early season and moderate in late season. In July, oviposition by moths occurred within the plant canopy, which was rather atypical for that time. August populations of tobacco budworms were high in a few, scattered fields, particularly in the northwest. Fall armyworms infested some late, green fields, and efforts to control large larvae were generally unsuccessful.

Heavy aphid infestations were a problem in many fields. Some fields required more than one application due to population resurgence even though the initial application appeared effective. Heavy populations of western flower thrips occurred throughout the Red River Valley, and this pest was also detected in high numbers in 2 fields in the northeast (Caldwell Parish).

Mississippi. In 1985, thrips populations varied from above normal in some fields to below normal in others. Tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), and cotton fleahopper populations were below normal, but fleahopper populations made up a higher than normal percentage of the populations. Boll weevil populations were at low levels in early season, but built to high levels by late fall. *Heliothis* populations varied, but overall were greater than at any time since 1978. Spider mites, particularly in the Delta area, and aphids occurred at high levels, often requiring multiple chemical treatments. Fall armyworms were a problem in most counties and were severe in some fields. Beet armyworm populations were scattered but reached damaging levels in a few fields. Whiteflies were at very low levels in most areas.

New Mexico. Planting was later than normal this year in the Pecos Valley and many fields were replanted due to stand reductions caused by excessive rain and in some cases, hail. Plant growth was slow initially because of cool weather and soil temperatures.

Conditions in the Mesilla Valley were nearer normal. Thrips (primarily western flower thrips) populations were low to moderate and did not limit rapid growth once temperatures improved. Plant bug populations were also low to moderate with less than 50% of the fields being treated for these pests. In the Pecos Valley the cotton fleahopper was the major species present with various species of lygus bugs and the whitemarked fleahopper, Spanagonicus albofasciatus (Reuter), being less abundant. Lygus bugs were the predominant plant bug in the Mesilla Valley.

Beet armyworm, S. exigua (Hübner), and cabbage loopers, Trichoplusia ni (Hubner), populations attained damaging levels in isolated fields but tank mixes of insecticides with materials for thrips and plant bugs generally controlled these pests. Various species of grasshoppers caused economic damage to fields bordering pasture or other uncultivated areas and multiple chemical applications were often required for their control.

Economically damaging populations of the bollworm occurred ca. 2 wks later than in the past few years. Only about 80% of the fields in the Pecos Valley were treated but isolated fields were treated as many as 4 times with an average of about 1.25 applications per acre. Fewer fields required treatment in the Mesilla Valley. Although larvae were not collected for identification, pheromone trap catches in the Pecos Valley indicated lower tobacco budworm populations than had occurred in several of the past 6 years. Pyrethroids were predominantly used and no control failures were reported in either valley.

Aphid, Aphis gossypii (Glover), populations increased slowly during the season, but attained high levels in mid-August, especially in the eastern counties. Nevertheless, few fields were treated solely for aphids, and aphicides were tank mixed with pyrethroids that were applied for bollworm control. Populations of beneficial arthropods had controlled aphids in most untreated fields by early September. The pink bollworm continued to be trapped in high numbers in southern counties, but only isolated fields were found to have economic damage.

Excellent plant growth was achieved in late July and August. Rains received in September and October delayed picker harvest and crop maturity.

North Carolina. Crop year 1985 was highlighted by 1) severe thrips infestations across much of the state, 2) atypically high and low bollworm populations in northern and southern North Carolina, respectively, and 3) economically damaging green stinkbug and European corn borer levels in some areas. Other sporadic pests, such as beet and fall armyworms, spider mites, and cabbage loopers were generally low in density though aphids occurred in late season. The Boll Weevil Eradication Program appears to be on course, with the third (and final) year of the "eradication" expansion phase now history. Next year will mark the beginning of the containment phase for southern North Carolina and all of South Carolina. Although several hundred boll weevils were found in the "eradicated zone", no producers had to deal with economic levels of boll weevils, greatly simplifying bollworm management. Other pests and potential pests such as stinkbugs, plant bugs, and the European corn borer can be expected to increase in the coming years.

Warm, dry spring conditions coupled with the drying of wheat resulted in high thrips populations as well as a generally susceptible cotton crop. Temik treated stands were sometimes damaged (presumably non-activation problems) by thrips. Foliar treatments for thrips (unusual under typical North Carolina conditions) were common in 1985. Efficacy of recommended thrips insecticides was confirmed in replicated tests.

Bollworm pressure in northern North Carolina, though of generally short duration (2-3 wks), was early and high. Control plots in a screening test in this area had all fruit removed by Heliothis larvae for most of the fruiting period; these plots yielded only 8% as much cotton as that of the best treatment. A few fields which were inadvertently left out of scouting programs were virtually decimated. Producers of these fields who responded early, and with recommended products, escaped significant yield loss; those who waited often faced high numbers of larvae that were difficult to control.

The southern producers for the most part responded in a timely manner against a largely bollworm population, which required approximately 2-1/2 wks to control. Bollworm applications in this area numbered in the 3 to 6 range as opposed to the 4 to 8 applications typically required in this boll weevil free situation. Northern producers needed 2 to 5 treatments compared to a more typical 0 to 4.

European corn borers were again present throughout much of the state, further confirming the upward trend evident for the past few years. Statewide damage estimates were put at 6% on the basis of an 11 county survey of 118 fields. This places the European corn borer just behind the Heliothis complex in economic damage to cotton in North Carolina. Rank and/or late maturing cotton again appeared to be hardest hit.

Stink bugs [mostly Acrosternum hilare (Say) and a few Euschistus servis (Say)] were present at unprecedented levels, with damage highest in fields which received no insecticides or those in which Dipel® was used for bollworm control. Whereas statewide damage from stink bugs was low, boll damage in one county in the western Piedmont was 11%, with a few fields running as high as 25 to 30%. Although not the materials of choice for stink bugs, the pyrethroids Cymbush® and Pydrin® provided approximately 50% and 75% control of stink bugs for one and two applications, respectively, while managing bollworms.

Plant bugs and other occasional pests were at low levels in North Carolina this past year. Plant bugs again occurred at levels approximately 5 to 20 times lower than in other states where they are an economic problem. Aphids were widespread, particularly during late season, but in most cases where sooty mold could be found, subsequent stain was apparently not high enough to cause grade reductions. This is another potential pest which may occur at higher densities in the absence of insecticide applications for boll weevil control.

Oklahoma. Favorable growing conditions accelerated planting of the 1985 cotton crop. Most of the cotton in Oklahoma was 3 wks ahead of schedule.

The lateness of the 1984 cotton crop coupled with an average winter allowed boll weevil population to resurge. The average number of boll weevils captured per trap (placed adjacent to overwintering sites) in southwest Oklahoma was 1.73 as compared to 0.04 in 1984. By August, boll weevil populations were noticeable in area fields. In areas traditionally infested by weevils, fields were sprayed up to 3 times to prevent extensive damage. Favorable growing conditions ameliorated thrips and fleahopper problems, but some fields were treated for moderate level fleahopper populations.

Heliothis populations were light across southwest Oklahoma resulting in the majority of dryland cotton not being sprayed and irrigated fields requiring an average of 1 to 2 applications. Tobacco budworm moth captures lagged behind bollworm moth captures by 1.5 to 2 moths with bollworm moths being first caught on April 17 and budworm moths first being caught on June 1.

Two-spotted spider mites reached damaging levels, thereby warranting treatment in a few fields. No buildup of western flower thrips populations were observed. Lack of spider mite and flower thrips problems apparently is related directly to reduction of pyrethroid applications for bollworm control.

South Carolina. Boll weevils caused no economic injury to South Carolina cotton for the second year in succession. The Boll Weevil Eradication Program has been successful in suppressing weevils to noneconomic levels. Thrips numbers in seedling cotton became an economic problem about mid-May and continued to be a problem in early June, resulting in 1 to 2 foliar insecticide treatments. A sustained movement of thrips from small grains made it appear that recommended insecticides were ineffective. Beet armyworms were first observed in cotton in June, which is earlier than usual, but few economic infestations occurred.

Fall armyworms caused minor problems. *Heliothis* spp. occurred from 5 to 7 days earlier than normally expected with the F_3 generation causing economic problems in most cotton growing areas by July 15. The intensity of this infestation was greater than in 1984. Although there was some boll damage from European corn borers, it was lighter than in 1984. Cotton aphid infestations were common during late-season resulting in some fields being sprayed for aphids alone. A few fields also had light to moderate infestations of whiteflies. Stink bugs, primarily the southern green stink bug, *Nezara viridula* (L.), caused economic damage in a few fields by feeding on small bolls. This injury was compounded by heavy rains resulting in a considerable number of hard-lock bolls in infested fields.

Tennessee. Early season pests of cotton included thrips, fleahoppers, flea beetles, and tarnished plant bugs. Thrips and plant bugs were the more damaging pests. During the mid- to late-season, green stink bugs, *Heliothis*, and boll weevils damaged cotton. *Heliothis* damaged up to 20% squares in some fields. In a limited area of southern West Tennessee, boll weevils caused economic damage to squares. Green stink bugs probably caused the most widespread damage to cotton. They occurred in most fields and caused economic injury to the crop in most instances by injuring young bolls. Generally, cotton had a good growing season and weather conditions. Planting progressed well from mid April to mid May with little moisture problems. The harvest season progressed well with some rain hampering harvest.

Texas. Early infestations by thrips migrating from wheat to seedling cotton in the High Plains caused the need to replant ca. 500,000 acres. Thrips were also important in the Coastal Plains requiring insecticide applications in many areas. Cotton fleahoppers were particularly numerous throughout the Coastal Plains and the Rio Grande Valley where the highest populations were experienced since 1980.

The boll weevil continues to be effectively managed through the use of stalk destruction, delayed uniform planting, and early strategic mid-season use of insecticides. Some economically important boll weevil populations were experienced late in the season adjacent to favorable overwintering habitat in the Rolling Plains. Coastal Plains producers were required to use "overwintering insecticide applications" to effectively manage the weevil. Most other regions of the state experienced light to moderate weevil problems during the production season.

Bollworm populations were generally light to moderate in numbers, however, some areas of the Rolling Plains experienced their highest populations in recent years. These populations were generally associated with late-planted, irrigated cotton. Sporadic reports concerning the somewhat diminished effectiveness of pyrethroid applications for *Heliothis* occurred in the central, western, and Winter Garden regions of the State. A larval survey indicated that the tobacco budworm was often the predominant species. Resistance to pyrethroids was not specifically documented, but performance by this class of insecticides is being observed closely. The pink bollworm, *Pectinophora gossypiella* (Saunders), occurred in relatively fewer numbers in the far western regions of the state. Economically damaging numbers of pink bollworm were usually associated with poor stalk destruction during the fall of 1984.

Although still relatively minor in importance, spider mites and cotton aphids continue to be reported in production regions throughout the state. The continued use of pyrethroid insecticides may be a primary causal factor in the increased incidence of aphid and spider mite populations in the High Plains, Rolling Plains, West Texas, Rio Grande Valley, and Blackland regions of the State. Aphids were very easy to control and spider mites generally were treated with monocrotophos.

Estimated Damage to Cotton by Arthropod Pests

Insect losses and costs of control are developed annually by state extension service representatives from all cotton producing states. This information is compiled under the auspices of the Cotton Insect Research and Control Conference with support by the Cotton Foundation to help defray expenses associated with development of the data. Estimates of insect damage in 1985, by state, are presented in Table 1.

Additions to Insecticides/Miticides Registered for Cotton Pest Control

Compounds registered by EPA and labeled for use in controlling cotton arthropod pests through the 1983 crop year are listed in Table 4 of the 37th Annual Conference Report on Cotton Insect Research and Control. Reference to the Highlights of the 1985 Cotton Insect Research and Control Conference lists those compounds registered for use in cotton during 1984. For 1985, tralomethrin [Scout (Hoechst Roussel), cyano=(4-fluoro-3-phenoxyphenyl)-methyl-3-(2,2-dichloro=ethenyl)-2,2-dimethyl-cyclopropane-carboxylate)] and thiodicarb [Larvin (Union Carbide), Dimethyl N N'thiobis (methylimino) carbonyloxy bis ethanamodothioate] received registration for use in cotton.

Changes in Established State Recommendations for Insecticides and Miticides Used for Cotton Pest Control

Reference the Highlights of the 1985 Cotton Insect Research and Control Conference for changes in state recommendations for the 1985 crop year. Changes for 1986 are listed in Table 2 by the reporting state.

Insecticides and Miticides Showing Promise in Field Tests

Compounds tested by state and federal researchers during the 1985 crop year which exhibited good field performance are listed in Table 3 by the reporting state.

Research Progress and Accomplishments

Arkansas. Systemic insecticides for thrips control were evaluated under irrigated and dryland conditions. Seed cotton yields were about 1000 lb/acre greater under irrigation regardless of treatment, compared to dryland cotton. Yield trends in treatment also were similar under both conditions.

The systemics, especially Temik, tended to have higher first pick yields and total yields compared to the untreated, and in some cases, the foliar spray treatment. The foliar spray treatment was delayed in maturity compared to other treatments and had significantly lower yields the first pick.

Arizona. A diet (Cohen diet) made of beef hamburger, liver and sucrose was used to rear *Geocoris punctipes* Say for 12 continuous generations. It has supported *Podisus acutissimus* Stal and *Olla abdominalis* (Crotch) for 3 generations and *Nabis* sp. for 2. Other predators were tested, but failed to complete a generation.

The mymarid parasite of *Lygus* eggs, *Anaphes ovijentatus*, was successfully labeled with Rb by feeding *Lygus* on diet containing RbCl, which labeled their eggs and, in turn, the parasites developing on the eggs. This technique has been successfully used in field studies on dispersal of *A. ovijentatus*. Parasitization of *Lygus* eggs in cotton by *A. ovijentatus* was low.

The braconid *Leiophron uniformis* was encapsulated at a high level by the tarnished plant bug, but not by *L. hesperus*. A high degree of variation in ability to encapsulate was found among various cultures of the tarnished plant bug. (USDA, Tucson).

Boll weevils from the mid-south and from Brazil show high frequencies and even homozygosity of alleles at loci which are homozygous for different alleles in western weevils including those collected on wild cotton plants. The two most striking loci are isocitrate dehydrogenase-1 (IDH-1) and aspartate aminotransferase (AAT) where complete differentiation of weevils can be made on the gels by the location of the alleles. These loci can be used to discriminate southern from western boll weevils. No such positive markers have been observed to discriminate populations of weevils from wild cotton and cultivated cotton within Arizona. Thus, these populations may be assumed to be nearly panmictic with local differentiation due to isolation.

Cotton strains identified as having some insect resistance were crossed to the resistant standard, AET-5, or intercrossed with several other resistant sources. Parents and hybrid progenies were exposed to natural populations of pink bollworm in replicated field plots. Stoneville 7A Okra leaf, AET-5, and 7203-14-7 were the best combiners for pink bollworm resistance (low seed damage). The line 7203-14-104 was not as good a combiner for low seed damage. Thirty-two BC_2F_3 progenies coming from the resistant donor AET-5 crossed to two recurrent parents were evaluated for seed damage. Eight of these had significantly less seed damage than their recurrent parents but not significantly more than AET-5. Moreover, lint yield was as high as, or higher than, that of the recurrent parents.

At Tempe and Maricopa, AZ, chemical termination treatments with chlorflurenol, chlorflurenol plus Dropp®, and chlorflurenol plus Prep® were the most effective of 9 treatments in reducing the number of green boll and preventing regrowth and initiation of new squares at or after harvest. Yields were not significantly reduced by those treatments. Chlormequat and Chlormequat plus Dropp were slightly less effective in reducing the number of green bolls and plant regrowth. Dropp and Prep alone and in combination were least effective.

The Brawley strain of the pink bollworm appears to be about 21-fold more resistant to permethrin than the Tempe strain, whereas it is 5.7-fold more resistant to fenvalerate. The resistance level to both cypermethrin and flucythrinate appears to be 12 to 15-fold more. However, fewer moths of the Brawley strain have been treated with these two insecticides and these results may be considered preliminary. No significant difference in susceptibility to azinphosmethyl (the organophosphate) occurred between the Brawley strain and the laboratory strain. Also, the slopes of the regression lines were lower (flatter) for all of the field strains than the laboratory strains except for flucythrinate. This indicates a greater variability among moths from the field than among moths in the laboratory. This is characteristic of insect populations that are developing resistance to insecticides.

Studies were conducted to define the occurrence of the red secretory fluid in the primary simplex of tobacco budworm male moths in relation to age of males after emergence, transfer of the material to the female moths during copula, and its potential use to determine the mating status of male moths. The secretory fluid in the simplex of the ejaculatory duct at 1 to 5 h after male moth emergence was a dense, gel-like, creamy-white material, changing to orange white in 5 to 10 h, and progressively deepening in color thereafter from pink to dark red by 24 to 48 h. The red-colored fluid was transferred during the first mating to female moths by males up to 14 d old. The material remained identifiably red in the unmated males for at least 14 days. After the first male mating, the red secretory fluid was replaced by clear to translucent, less densely packed material, but red pigmentation was not observed to recur in mated male moths for up to 11 days after mating. Similarly, the red secretory fluid was identifiable for up to 11 d in the bursa copulatrix of the mated female partners.

Comparison of the parent cotton 'AET-5' (hirsute, nectaried, normal leaf shape) with its various mutants for whitefly resistance showed the following: the smoothleaf character alone or in combination with the other mutant characters significantly reduced numbers of both species of whitefly; the nectariless character had no significant effect on numbers of either species; the okra-leaf character increased numbers of both species; and the combination of nectariless okra-leaf did not reduce numbers significantly below those on the 'AET-5' parent. Comparison of all four entries carrying a specific mutant with the four carrying the parental character showed that only the smoothleaf entries reduced numbers of both species significantly; nectariless and okra leaf had no significant effect. Both 'Deltapine 61' and 'Deltapine NSL' harbored significantly fewer whiteflies of both species than did the parental 'AET-5' stock. 'AET-5' smoothleaf and smoothleaf-nectariless did not differ significantly from the 'Deltapine' cultivars. A comparison of the 'DES 24' cultivar with its semi-smoothleaf versions showed the following: numbers of _B. tabaci_ were significantly higher on semi-smoothleaf-nectariless and on semi-smoothleaf nectariless okra-leaf; and numbers of _T. abutilonea_ were higher only on semi-smoothleaf nectariless okra-leaf. Numbers of both whitefly species were significantly higher on nectariless okra-leaf but not on nectariless; 'Deltapine 61' and 'Deltapine NSL' did not differ significantly from 'DES 24' or 'DES 56' in numbers of either species. Comparison of the numbers of _B. tabaci_ on the seven 'Deltapine' and the two 'Stoneville' cultivars showed that all but one of the 5 semi-smoothleaf 'Deltapine' cultivars, 'Deltapine 120,' had significantly fewer _B. tabaci_ on sticky traps than both of the pubescent 'Deltapine' cultivars, 'Deltapine 70' and 'Deltapine 41'; the two pubescent 'Stoneville' cultivars had significantly fewer _B. tabaci_ on the sticky traps than did 'Deltapine 70,' but did not have significantly more than the majority of the semi-smoothleaf 'Deltapine' cultivars; and 'Deltapine 41' had significantly more pupae on the leaf sample than did any other cultivar, but none of the others differed significantly.

The beet armyworm continues to be an important pest of cotton, alfalfa and many vegetable crops in the southwestern United States. _Microplitis rufiventris_ was imported from Egypt for release against noctuids. Laboratory studies provided estimates of both lower (10.3°C) and upper (29.5°C) thresholds for development with the parasite requiring 207.2 day degrees (D°) to complete development from egg to adult. The parasite wasp successfully attacked and parasitized second instar beet armyworms and regardless of rearing temperature, usually emerged from fourth instars. Mortality of immature wasps ranged from 0.0 to 21.0% between 17.5 and 32°C; all individuals died at a constant temperature of 33.5°C. Adult longevity declined as a function of temperature, ranging from about 25 d at 17.5°C to 4 d at 32°C.

Adult bollworms began to emerge from pupal cells in the soil at ca. 2100 h with undeveloped wing pads. They rapidly moved to the corn stubble to assume a vertical position on the stalks with their heads oriented upward. They positioned themselves about 15 cm above the soil. There they began inflating their wings, a process that took an average of 18.3 min. After remaining motionless for about 2 min., they extended their wings overhead and held them in that position for an average of 25 min., after which the wings were lowered to the normal resting position. The adults then remained on the stubble in a very docile condition for another 101 min. before taking their first flight. Their first flight was usually a short range flight of less than 20 m and occurred about 2.5 h after emergence.

There were two peaks of flight activity of the newly emerged bollworm moths. The first peak occurred between midnight and 0100 h, about 2 h after peak emergence, and the second peak occurred between 0400-0500 h. The moths did not leave the field during the first flight activity period. They left the field between 0430-0515 h. Their destination was not measured but those leaving the field appeared to be oriented downwind. (USDA, Phoenix).

California. The San Joaquin Valley Research Program emphasized field evaluation of resistance in spider mites to the acaricides dicofol and propargite, the influence of selected pesticides on infestation development, economic threshold, and evaluation of selected candidate acaricides. Resistance to dicofol and propargite is evident in some populations of the pacific and two-spotted spider mites. Infestation development is greatly enhanced by specific insecticides that do not possess miticidal properties. Dicofol and propargite continue to be very effective against a majority of the spider mite infestations. The candidate miticides MK936, Apollo ABG6162 and DPXY5893 appear to have promise for spider mite control. (Univ. California - Davis).

Georgia. Bollworm females that had mated with normal and irradiated (10 krad) males and then held for 24 h were not significantly ($P < 0.05$) different in their attractiveness to males. However, these females (mated + 24 h) were significantly ($P < 0.05$) less attractive than virgin females or mated females held 48 h after mating. Females that had mated with normal males and then held for 48 h were not significantly ($P < 0.05$)

different from virgin females or females that had mated with irradiated (10 krad) males and then held for 48 h.

The attractiveness of females that had mated with F_1 males [progeny from irradiated (10 krad) male x normal female] and held for 24 h was significantly ($P < 0.05$) greater than the attractiveness of females that had mated to normal males and held for 24 h. Again, females mated to normal males were significantly ($P < 0.05$) more attractive 48 h after mating than 24 h after mating. No significant differences were observed between the attractiveness of F_1 mated females 24 and 48 h after mating. Mated females held for 48 h after mating were not significantly ($P < 0.05$) different from virgin females in their attractiveness to males.

The mating propensity of females with different mating histories supported the data from the above trapping study. Females that had mated with normal or irradiated (10 krad) males and held for 24 h were not significantly ($P < 0.05$) different in their ability to secure a second mate. Females that had mated with F_1 males and held for 24 h secured significantly more mates than females that had mated with normal males and held for 24 h. (USDA - Tifton).

Louisiana. In enclosed 1 m plots infested with 9 to 11-d-old cutworms, Baythroid® at 0.01 and Pydrin® at 0.1 lb(AI)/acre gave comparable control to Lorsban® at 1 lb(AI)/acre.

In a comparison of 3 insecticides for efficacy in controlling tarnished plant bugs and cotton fleahoppers, Lorsban at 0.185 or 0.25 lb(AI)/acre gave similar control to Cygon® at 0.2 and Cythion RTU® at 0.5 lb(AI)/acre. Plots were 15 acres with each treatment replicated 3 times.

Lorsban at 0.25 and Cygon at 0.2 lb(AI)/acre were not significantly ($P < 0.05$) different with respect to controlling aphids in large plots (20 acre plots replicated 3 times).

Lorsban at 0.5 lb(AI)/acre applied twice (5-d intervals) in 10 gal of water/acre using a John Deere high clearance sprayer significantly ($P < 0.05$) reduced spider mites. However, 14 d after the initial treatment, it was necessary to apply Kelthane since mite numbers were too high.

In an experiment designed to determine the influence of Triton CS-7 (0.25% of finished spray) on spray coverage, it was found that the addition of this adjuvent increased the number of droplets 20% in a clear level area. In tests on cotton foliage, an increase of 157% was obtained for drops/cm^2 in the upper canopy, 226% in mid canopy and 272% in the lower canopy.

The western flower thrips extended its range to a total of 6 parishes during 1985. It was found for the first time in the eastern part of Louisiana where 80% of the cotton in Louisiana is produced. Monitor® at 0.3 lb(AI)/acre was the only chemical that satisfactorily reduced western flower thrips populations in the field. Treated populations increased to levels found prior to treatment in 5-7 days. Two to 3 applications will be required to obtain control. Chemicals tested that were not satisfactory included Sevin®, Larvin, Proxol®, Azodrin®, Orthene®, Curacron®, Furadan®, Temik®, Cygon®, and malathion. (Louisiana State Univ.)

Mississippi. With the support of a joint MAFES-MCES project, the Cotton and Insect Management (CIM) Model is being structured for use on personal computers. The purpose of this project is to make the model accessable at the farm level. On-going application research indicates that mortality of *Heliothis* spp. larvae exposed to insecticide sprays is influenced by several application variables (dosage, deposit density, droplet size, and droplet concentration), but the most important variable appears to be dosage. However, variables influencing application differ between water and oil sprays. With oil sprays, droplet size appears to influence mortality nearly as much as dosage. With water sprays, droplet sizes within the range of normal application do not appear to influence mortality if other variables are held constant. A proposed resistance management program for *Heliothis* that emphasizes pesticide mixtures, particularly chlordimeform and methomyl in mixtures with pyrethroids, appears to show promise under good management. Research conducted in cooperation with Cotton Incorporated also suggests that chlordimeform-pyrethroid combinations may result in synergism of mortality of larvae and adults of *H. virescens* exposed to the treatment. Research initiated in 1982 to quantify, for modeling purposes, the mortality of *Heliothis* spp. exposed to insecticides is completed. Mortality estimates will be published that are a function of developmental stage, temperature, and persistence of the insecticides studies. A 3-year fruit tagging and fruit removing study conducted to estimate the relative value of cotton fruit as a function of fruit age and week of fruiting is being analyzed. Large and small plot field studies conducted to measure the impact of automatic insecticide application applied early in the growing season on cotton fruit retention, yield, and arthropod populations suggest that: 1) some insecticides prevent yield losses and delays in maturity in the presence of damaging populations of pests; 2) automatic insecticide applications can disrupt the arthropod complex present in cotton; 3) insecticide selection should be made on the basis of type and density of pests present; and 4) that variation in response of cotton to automatic applications is great from location to location, probably because of different environmental and pest situations. A preliminary project was conducted in Arizona to study movement of releases of sterile male hybrid-*H. virescens* adults. Results indicate minimal movement of released moths into cotton fields beyond 10 miles of the release site. Probability of retention of eggs of *H. virescens* on cotton in the face of physical environmental factors in the field was found to be about 15% lower on smooth compared to normally hirsute varieties. (Mississippi State University).

A field experiment comparing the APHIS standard program (SP) with SP + sterile boll weevils (200/acre released every 5 days), and SP + 2 infield traps per acre was conducted in the buffer zone of the Southeastern Boll Weevil Eradication Program in South Carolina. More than 420 fields and 10,500 cotton acres were included in this experiment. The analysis indicated that the SP treatment currently used by the APHIS operational team is effective in preventing reproduction by the incipient overwintered boll weevil populations that emerged into cotton plantings in this experiment. Very early planted fields in one of the four APHIS Work Units accounted for a high percentage of fields where reproduction occurred. Trends indicated that reproduction was inversely related to delays in planting. In two Work Units (306 and 309) where there was the least variability in planting date and population densities, there were significantly fewer fields with reproduction in the SP plus sterile weevil treatment than in the other treatments.

Included in this experiment were substantial improvements in sterilizing, shipping, and releasing boll weevils for population suppression. In the 1979 Boll Weevil Eradication Trial (BWET), sterile weevils were 6.2% competitive and the LT_{50} (the day after irradiation by which 50% of the weevils had died) for the treated weevils held individually in screen boxes on cotton plants was 5 days. In 1985, the competitiveness of weevils released in South Carolina was 19.2% for 7 days following release. Perhaps more important, the competitiveness of these weevils on days 4-7 was 17% or about 8 times greater than in the 1979 BWET. The LT_{50} of the weevils released in 1985 was 7.5 days or 50% longer than in 1979. In other experiments in 1983 against much larger populations than in 1985, egg hatch was reduced 61%.

In 1979, sterile weevils were previously released free fall into the cotton fields. Subsequent studies showed that they could be entrapped in loose sandy soil or killed if they landed on host soil surfaces. In 1985, sterile weevils were released in small, shotgun shell sized containers providing them a surface on which to crawl to prevent entrapment. Also, releases were made in the mornings to avoid excess soil temperatures. In 1979, sterile weevils were shipped in chilled containers which appeared to reduce their vigor. In 1985, since the sterile weevils were packaged in release containers, they were shipped in boxes which were not chilled. All of these improvements were incorporated into the 1985 field experiment.

Native female boll weevils discriminated against

squares damaged by any cause but especially against those containing boll weevil ovipositional damage. Field observations showed that female weevils oviposited in 85% of the undamaged squares encountered, compared with 19% oviposition in squares already containing boll weevil ovipositional damage. Squares damaged from causes other than boll weevil damage were oviposited in 38% of the time. Results of several types of laboratory experiments supported the field data.

Gamma irradiation of 10 krad does not fully sterilize the female weevil. Previously, the insect growth regulator, diflubenzuron, has been used to provide the irradiated female sterility by adding diflubenzuron to the adult diet at low concentrations (100 ppm) for 5 days. The feeding of diflubenzuron prevented cuticle hardening. A new procedure that force fed diflubenzuron to 300,000 weevils at a time by submerging them in a 4,000 ppm Dimilin solution for 10 min prior to the 10 krad gamma irradiation avoided this problem. Careful testing of 975 female weevils paired with normal virgin adult male weevils showed 100% sterility. The 6,855 eggs laid by the sterile weevils showed no hatch. This procedure was used during the South Carolina sterile release experiment.

A quality assessment program was begun which tested: 1) mobility, 2) flight, 3) microbial contamination, 4) incidence of sexual sterility in sterilized males and females, 5) weight, 6) egg hatch and production of the standard colony, 7) sex ratio, and 8) survival. New additions to the assessment program include visual sensitivity and pheromone production.

Seasonality of pheromone production was studied in field populations of boll weevils. During the overwintered and first generations of field weevils pheromone production appeared normal. However, during the second field generation, pheromone production appeared normal. However, during the second field generation, pheromone production ranged from almost none to normal in some males. In September, pheromone production was extremely low for all samples observed. This seasonal cessation of pheromone production is probably, in part, responsible for the dispersal phenomenon.

In addition to studies of the olfactory receptor system in the boll weevil, electrophysiological studies were also done on the boll weevil compound eye. Preliminary results in another laboratory revealed photosensitivity of the compound eye of the Gast reared weevil to one wavelength of light (510 mm), which is less than that of field-weevils. However, spectral sensitivity curves to visible light for both field and Gast-reared weevils were similar. Further studies revealed that addition of -carotene, a vitamin A precursor, significantly increased photosensitivity of the Gast weevil to a level not significantly different from the field weevil. Spectral sensitivity curves for both the -carotene and field weevil were nearly identical. (USDA - Starkville).

Thiodicarb, chlordimeform, cypermethrin, or thiodicarb plus chlordimeform were applied at weekly intervals during the first 4 wk of squaring to cotton grown in western Sunflower County, Mississippi in 1985. Except for big-eyed bugs, <u>Geocoris</u> spp., no other beneficial species averaged more than 2500 individuals per hectare in any week in the insecticide and check treatments. Significant differences were not found in the number of beneficial arthropods of any species in any week in the chlordimeform or thiodicarb treatments. Mortality of the beneficials in the chlordimeform plus thiodicarb treatment tended to be higher than when either insecticide was used alone, but was significantly higher than either treatment only in week 2 of the test. The highest mortality of beneficial arthropod populations was found in most weeks in the cypermethrin treatment.

The cotton fleahopper was the most abundant pest found in the study. Adult and nymphal cotton fleahopper populations were lower in all insecticide treatments in most weeks than in the check. Significantly lower populations as compared to the check were found most commonly in the cypermethrin treatment. <u>Heliothis</u> populations were low and square and boll damage never exceeded 2% in any week. None of the insecticide treatments resulted in significantly higher yields than were obtained in the check.

Roadside vegetation may serve as important habitat for pest and beneficial arthropods of field crops in the Delta of Mississippi. Crimson clover, <u>Trifolium incarnataum</u> L., is frequently included in seed mixtures used by State and County Highway Departments to establish roadside vegetation. It has been documented that this clover is a preferred host of the first larvae generation of the bollworm and the tobacco budworm. The ARS Southern Field Crop Insect Management Laboratory and the Mississippi State Highway Department are cooperating in research designed to identify species of legumes that are less suitable than crimson clover as hosts for <u>Heliothis</u> spp., are compatible with roadside management practices, and do not adversely affect beneficial arthropod populations. The following six species of legumes are being evaluated: crimson clover; red clover (<u>T. pratens</u>); white clover (<u>T. repens</u>); ball clover (<u>T. nigrescens</u> L.); subterranean clover (<u>T. subterranium</u>); and vetch (<u>Vicia sativa</u> L.). Two species of grasses that are frequently included in roadside seed mixtures, fescue (<u>Festuca elatior</u> L.) and bermuda grass (<u>Cynodon dactylon</u> Pers.), are also included in the study.

The impact of scheduled early-season insecticide applications on cotton arthropod populations and yield was studied in 1985. Nine insecticides representing 4 classes (organophosphates, carbamates, synthetic pyrethroids, and formamidines) were tested in a large field plot study in Sunflower County. Dimethoate, dicrotophos, acephate, chlordimeform, cypermethrin, cyfluthrin, fenvalerate, and flucythrinate were applied at rates of 0.15, 0.15, 0.33, 0.125, 0.04, 0.022, 0.10, and 0.025 lb AI/acre, respectively. Weekly applications of the above treatments were made during the first 3 wks of squaring to cotton that had received an in-furrow application of aldicarb (0.50 lb AI/acre) at planting for thrips control, and to non-aldicarb treated cotton. Populations of most of the major beneficial arthropods in the insecticide treatments were reduced to levels below those found in the check. Tarnished plant bug populations were low during the test and the adult and nymphal populations seldom exceeded 1000/acre. All insecticide treatments reduced tarnished plant bug populations below that of the untreated check. The cotton fleahopper was the most abundant cotton pest found during the study, and all insecticide treatments reduced populations of this pest below levels in the check. Combined populations of the tarnished plant bug and cotton fleahopper were throughout the test and apparently had no major eff on fruiting of the cotton plant or on yield. None o. the insecticide treatments had significantly higher yields than the check, although the treatments (except chlordimeform) that received aldicarb at planting yielded from 66 to 712 pounds per acre more seed cotton than they did without aldicarb. The increase in yield in the aldicarb treated cotton may have been due to better control of secondary pests such as aphids and spider mites which were a problem, especially in the pyrethroid treatments.

Topical application of fourteen technical grade insecticides to <u>Microplitis croceipes</u> (Cresson) (Hymenoptera: Braconidae) adults up to 48 h-old showed that the wasp tolerated certain compounds. No dosage-mortality response was obtained for chlordimeform, diflubenzuron, or thiodicarb when up to 2,500 ng/insect was applied. The organophosphate mixture methyl parathion-EPN was most toxic, while fenvalerate was least toxic, with LD_{50}'s of 13 and 940 ng/insect, respectively. LD_{50}'s (ng/insect) for the carbamate methomyl (405) and the pyrethroid flucythrinate (397) were similar. LD_{50}'s (ng/insect) for the remaining insecticides were chlorpyrifos, 22; azinphosmethyl, 25; malathion, 52; sulprofos, 137; permethrin, 203; toxaphene, 246; and dicrotophos, 309.

A new erythraeid mite was discovered that is parasitic in the larval stage on tarnished plant bug nymphs and is predaceous in the nymphal and adult stages on all forms of the tarnished plant bug. This mite is found in undisturbed habitats adjacent to cotton fields from April to September and during July may parasitize as many as 30% of the nymphs in such habitats. (USDA -Stoneville).

<u>New Mexico</u>. Yield and lint quality data from a timing of application of Orthene[5] for fleahopper control study conducted in 1984 indicated no signifi-

cant differences in yields among treatment dates. The same results were obtained from a screening trial conducted in 1984 which compared two rates of application of Vydate® with Lorsban and Orthene standards. These results indicate little advantage for treatments when the primary plant bug species present is the white-marked fleahopper. Screening studies for plant bug control efficacy and yield effects were continued in 1985 with three studies being conducted. In addition, a trial was initiated to study the advantage of phosphorus fertilization with and without thrips control. Yields were not significantly different from the 19 treatments evaluated for control of Heliothis in 1984, but the amount of seed cotton and lint per boll was increased by some treatments. Fiber quality generally was not affected by these treatments. A study of 14 treatments was initiated in 1985, but Heliothis populations did not build to high numbers in all plots following earlier applications of plant bug control. An additional 7 treatments (aerially applied) were evaluated for Heliothis control in 1985 in a large-plot study. In two other studies, the effects on aphid populations of two materials commonly used for bollworm control on cotton were evaluated. Insect population data from the 1985 studies are still being analyzed and yield and fiber quality data are being collected for analysis. (New Mexico State Univ.)

Oklahoma. Six cultivars of upland cotton were tested for cotton fleahopper preference. Camd-E and frego bract were preferred for oviposition, Deltapine 90 and Westburn M were least preferred. No correlation could be determined with any of the morphological characteristics of the cultivars.

Varying spray regimes were used to study the relations of time of cotton fleahopper infestation and cotton yield. The test consisted of no, early, mid, late, and all season chemical control. No significant differences in yield occurred, but this test must be conducted for 1 to 2 more years.

Computer simulations were run to evaluate multiple comparison techniques applied to discrete distributions. The multiple comparison procedures considered were Fisher's protected least significant difference (LSD), Fisher's unprotected LSD, 'Student' -Newman-Keuls, Tukey's HSD, Duncan's protected multiple range test, Duncan's unprotected multiple range test, and the Bayesian k-ratio t-rule. The geometric, negative binomial and logarithmic distributions were the distributions in the study. Recommended transformations were compared to raw data and the Conover-Iman rank transformation for numerous situations arising within a randomized complete block design for each of the multiple comparison procedures. None of the methods proved to be best for all situations. In general, Fisher's protected LSD, Duncan's protected multiple range test, and the Bayesian k-ratio t-rule had greater power while controlling the Type I error rate. The rank transformation method seemed to provide better results in more cases than either analysis of the raw data or the recommended transformations. Computer simulation were used to evaluate five goodness-of-fit procedures: Pearson's chi-square, Hinz-Gurland minimum chi-square test, the Freeman-Tukey test, the Nass test, and the log-likelihood ratio test. Both the Type I and Type II error rates were evaluated using the negative binomial and Neyman Type A distributions. No one test proved superior. The Hinz-Gurland test showed promise, but had extremely poor power in some circumstances. The Pearson's chi-square test was the most consistent in controlling the Type I error rate without an excessive Type II error rate.

Insecticide studies for Heliothis spp. control consisted of evaluating 11 different chemicals or chemical combinations. All treatments were significantly different from the check although no differences was noted between treatments. Shell's MO-79900 at 0.025 lb AI/acre and Baythroid 0.025 plus Bolstar at .5 lb (AI)/acre had lowest square damage over the course of the study. Cotton fleahoppers also were evaluated after the first application. Baythroid at 0.025 lb AI/acre plus Bolstar at 0.5 lb AI/acre and ICI-PP 321 at .025 lb AI/acre were the most effective materials in the test reducing fleahoppers by 81% over the untreated check.

In another early season test for fleahopper control, Capture® at .04 lb AI/acre and Azodrin at 0.1 lb AI/acre were the most effective chemicals tested. All treatments were ineffective 13 days after treatment. All treatments reduced beneficial populations below the check although differences were insignificant.

A yield enhancement study involving Pydrin and chlordimeform has entered its second year. This test involves 4 different cultivars treated at pin-head square and thereafter at weekly intervals until maturity. Chlordimeform had a significantly higher yield than Pydrin or the untreated check after the first year. (Oklahoma State Univ.)

South Carolina. During 1985, in small-plot tests for insect control, Capture® (0.04) (pounds AI), Baythroid® (0.02 and 0.03), Mavrik® (0.055, 0.066, and 0.075), IC 321 (0.01, 0.015, and 0.025) and MO-70616 (0.035) produced yields at first picking comparable to the treated control, Pydrin® (0.01). Capture (0.06) had a greater yield than the treated control and MO-70611 (0.03) and MK-936 (0.02) had less.

An electrophoretic key for distinguishing seven species of immature and adult jumping spiders of the genus Phidippus was described. Twelve gene loci from 10 enzymes were analyzed. Mean heterozygosity of seven species was 0.117 with an average polymorphism of 0.146. Genetic distances between the species were determined. Feeding preference studies demonstrated that the bollworm preferred diets with cottonseed flour, soybean protein, and wheat germ over casein-wheat germ mixtures. However, in utilization studies the casein-wheat germ mixtures were better than diets with cottonseed flour. Average respiratory levels in boll weevils captured in pheromone traps, five miles from cotton were found to decrease from August to October with a significant drop after October 1. In August, less than 5% of the weevils had a respiratory level of less than 1 l O_2/ng wet wt/hr; after October 13, over 50% were in this group.

The seasonal occurrence of 15 species of adult Lepidoptera captured in a 15W blacklight trap was summarized. The data had been collected over a 9 to 10 year period, except for the European corn borer which has been recorded for four years. (USDA - Florence)

In a small-plot test for Heliothis spp. control, Karate® (0.015, 0.02, 0.025, and 0.03), Capture® (0.04 and 0.06), Cymbush® (0.04 and 0.06), Ammo® (0.05), Scout® (0.017), and Baythroid® (0.033) all reduced percentage square and boll damage to below 5 and 3, respectively, compared to 13.5 and 8.2%, respectively, for the untreated check. Earliness and yield differences among treatments (untreated check omitted) lacked significance. Evaluation of 7 cotton varieties for susceptibility to thrips indicated that Coker 315 an. Coker 304 were the most tolerant, while PD-2 and McNair 235 were the most susceptible. Thrips population densities at the 2nd-leaf stage ranged from 2 (Coker 315) to 19 (McNair 235) with corresponding yield reductions of 1.3 and 25.2%, respectively.

Six early-season applications of Fundal® at 0.125 lb AI/acre to 7 cotton varieties, on which thrips were controlled with Temik, for yield enhancement evaluation yielded inconclusive results ranging from a 10.4% yield increase for Coker 315 to a 10.4% decrease for McNair 235. In the absence of thrips control, yield enhancement with these Fundal applications ranged from a 10.3% increase for PD-1 to a 16.5% decrease for PD-2. (Clemson Univ.) Texas. Blacklands - Tarnished plant bugs dominated the plant bug populations being 2 to 3 times as great as cotton fleahopper populations. Control difficulty with organophosphates was general. Boll weevil and bollworm populations, in general, were low; few budworms were reported.

In studies with aldicarb applied in-furrow and sidedress 1, 2, and 3 wks after emergence, it was found that the plant growth measured as number of squares, leaf area, and wet and dry weights of stalk were significantly reduced with increasing rates of aldicarb. Rates were 0.0, 0.5, 1.0, 2.0 and 4.0 lb/acre in sterile soil. The conclusion is that aldicarb did not stimulate cotton plant growth except in the case of pest control.

Studies in a Blacklands location of effects of

uncontrolled fleahoppers on cotton varieties showed that loss of lint per acre ran from 200-300 pounds in first harvest. The variety CAMD-E was damaged less than most other cotton varieties. First harvest loss in the glabrous TAMCOT Sp-21 was sharply greater than CAMD-E.

Rolling Plains - Boll weevil and bollworm densities have been compared in dryland, furrow-diked, and irrigated cotton plots for the past 2 years to determine the potential impact of furrow-diking on pest problems. During very dry years, such as 1984, furrow-diking does not increase pest problems. Sufficient rainfall was received in 1985. Boll weevil populations were higher in furrow-diked cotton than in dryland cotton, but highest numbers occurred in the irrigated plots. Bollworm densities were comparable in dryland and furrow-diked cotton, and highest numbers occurred in irrigated cotton.

April-planted sorghum provides a reservoir for bollworm parasites which migrate to cotton. In the Texas Rolling Plains, early-planted sorghum matures in mid-July. Parasites then move to early-planted sorghum, which matures in mid-July. Parasites then move to cotton. Parasitism rates were 5-fold higher in cotton planted adjacent to early sorghum as compared to cotton isolated from sorghum.

There are late season edge effects in dryland cotton. This edge effect is confined to the outside row and to the last 10 ft at the ends of rows. More squares and soft bolls occur along the field margins, and boll weevils congregate along field margins. About 80% of dryland fields exhibit a late season edge effect sometime during September and October.

Lower Gulf Coast - Large Plot Studies. (1) Cotton treated 'at-planting' with Temik (0.75 lb AI/acre) produced significantly higher yields than untreated cotton in first and total harvests. Further, Temik treated cotton tended to have fewer fleahoppers throughout the season compared to the untreated check; (2) cotton treated with Larvin (0.125 lb AI/acre), Larvin (0.5 lb AI/acre) or Fundal (0.25 lb AI/acre) produced higher yields than untreated cotton in first and total harvests. Further, each of these treatments significantly reduced fleahopper numbers compared to the untreated check. Both Larvin treatments were applied 4 times (over 1 month) beginning at the third true-leaf stage, whereas the Fundal treatment was applied only twice (over 2 weeks) beginning at third true-leaf; (3) ultra-low-volume applications of Larvin (0.6 lb AI/acre) and Ammo (0.06 lb AI/acre) were equally effective in controlling moderate Heliothis infestations. Further, no difference occurred between the treatments in lint production.

Small plot study. Cotton treated with multiple early-season applications of Dyfonate MS (0.25 lb AI/acre), Dyfonate MS (0.5 lb AI/acre), Cythion RTU (1.03 lb AI/acre), or Karate (0.02 lb AI/acre) had significantly fewer fleahoppers compared to untreated cotton. Further, the high rate of Dyfonate and Karate caused a significant reduction of aphids compared to the untreated check. Only Karate produced significantly more lint than the untreated check. However, there was a strong trend for the other treatments to produce higher yields compared to the untreated check. (Texas A&M Univ.)

An improved method has been developed for collecting Eucelatoria bryani larvae from parasitized Heliothis spp. larvae. This method significantly increases the number of E. bryani that can be produced in vitro because it removed the necessity of slowly dissecting maggots from hosts.

Evaluations of the susceptibility of eggs of Heliothis zea of different ages to parasitization by Trichogramma pretiosum indicated that eggs incubated at 26.7°C were equally susceptible throughout most of the period of embryonic development. A decrease in parasite emergence from eggs 48 hours or older occurred; however, larval hatch from parasitized eggs was not observed. (USDA - College Station).

Acknowledgements

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TABLE 1 - ESTIMATED REDUCTION IN 1985 COTTON YIELDS RESULTING FROM INSECT DAMAGE.[a] TOTAL YIELD 13,622 bales

INSECTS	Loss in	STATE AL	AZ	AR	CA	FL	GA	LA	MS	MO	NM	NC	OK	SC	TN	TX	VA	No. Bales Loss	Total % Loss
Boll Weevil Anthonomus grandis Boheman	Percent	5.2	0.4	1.5	.003	5.55	6.01	4.5	0.85	0	0	NA	.15	0	0.1	0.48	0	133.61	0.98
	Bales	26.0	4.0	10.5	.10	1.94	21.64	34.2	14.28	0	0		.39		0.4	[illegible]0.16	0		
Bollworm-tobacco budworm Heliothis zea (Boddie) Heliothis virescens (F.)	Percent	2.6	1.0	1.8	0.7	4.32	3.61	4.0	1.3	1.0	2.5	8.5	5.0	4.3	3.0	3.78	15	330.18	2.4
	Bales	13.0	10.0	12.6	22.4	1.51	13.0	30.4	21.84	1.95	1.88	5.78	13	7.74	12	158.76	.32		
Cotton fleahopper Pseudatomoscelis seriatus (Reuter)	Percent	0	.01	1.0	0	0	0.21	0.5	0.5	0	2.0	NA	1.0	0.1	0.1	0.62	0	50.78	0.37
	Bales	0	.1	7.0	0	0	0.76	3.8	8.4	0	1.5		2.6	0.18	0.4	26.04	0		
Lygus spp. and other plant bugs	Percent	1	1.10	2.0	0.63	.03	1.0	0.7	0.64	5.0	2.5	0.5	0	0.5	3.2	0.14	0	101.63	0.74
	Bales	5	11.0	14.0	20.16	.01	3.6	5.32	10.75	9.75	1.88	0.59	0	0.9	12.8	5.88	0		
Cotton leafperforator Bucculatrix thurberiella Busck	Percent	NA	.05	NA	0	NA	NA	NA	NA	NA	0	NA	0	NA	NA	0	NA	0.5	trace
	Bales		0.5		0						0		0			0			
Pink bollworm Pectinophora gossypiella (Saunders)	Percent	NA	2.6	NA	0.11	NA	NA	NA	NA	NA	2.0	NA	0	NA	NA	0.06	NA	33.54	0.25
	Bales		26		3.52						1.5		0			2.52			
Spider Mite Tetranychus spp.	Percent	0.2	0.4	0	0.5	.02	0.12	0.3	1.04	.05	0.5	0	.05	0.5	0.5	0.59	0.5	69.49	0.51
	Bales	1.0	4.0	0	16.0	.01	0.43	2.28	17.47	.1	0.38	0	.13	0.9	2.0	[illegible]4.78	.01		
Thrips Frankliniella spp.	Percent	0.2	.02	0.8	0.25	.13	0.42	0.6	0.26	2.0	2.5	1.0	0	1.8	0.5	1.19	0.5	91.45	0.67
	bales	1.0	0.2	5.6	8.0	.05	1.51	4.56	4.37	3.9	1.88	1.15	0	3.24	2.0	[illegible]9.98	.01		
Others c,d,e,f,g,h,i,j,k,l	Percent	c,i,l 1.54	d,e 1.3	0	k,e,d 0.205	c 1.18	i,c 0.31	i,c,l 0.9	e,j,h,k 2.120	i 0.25	d,e,h,i 3.1	[illegible] e 6.7	0	c,d,e,f,i 3.5	e 4.7	i h 1.14	0	147.96	1.1
	Bales	5.9	13	0	6.56	0.41	1.12	6.84	35.62	0.49	2.33	7.71	0	6.3	18.8	[illegible]7.88	0		
Total Percent Loss	Percent	10.38	6.88	7.1	2.4	11.26	11.68	11.5	6.7	8.3	15.13	[illegible].7	6.2	10.7	12.1	8.0	16.2		7.01
Total Bales Loss	Bales	51.9	68.8	49.7	76.74	3.93	42.06	87.4	112.73	16.19	11.35	19.22	16.12	19.26	48.4	336	0.34	955.23	
Cost Control/Acre[l]	Dollars	48.12	95.00	32.00	15.85	82.80	88.57	59.50	37.60	14.30	17.00	33.00*	14.00	46.20	9.50	9.56	28.00	24.78[m]	
Yield in bales[m]	Bales	500	1,000	700	3,200	34.9	360	760	1,680	195	75	115	260	180	400	[illegible],200	2.1	13662	
Acres hvst. x 1,000		327	390	440	1,340	21.5	255	635	1,030	152	55	88	355	122	330	[illegible],700	1.7	10252.[o]	

[a] All bale figures in table x 1,000. Estimated by research, Extension and others based on Statistical Reporting Service December Report.

[b] NA, not applicable. [c] Fall armyworm (Spodoptera frugiperda (J. E. Smith)); [d] Beet armyworm (Spodoptera exigua (Hübner)); [e] Stink bugs (several spp.); [f] European corn borer (Ostrinia nubilalis (Hübner)); [g] Yellowstriped armyworm (Spodoptera ornithogalli (Guenée));

[h] Grasshoppers (Schistocerca americana (Drury)); [i] Cotton aphid (Aphis gossypii Glover); [j] Cutworms (Agrotis spp.) (Feltia subterranea (F.)); [k] Whitefly (Trialeurodes abutilonea or Bemesia tabaci); [l] Western Flower Thrips; [m] Average cost for all states [n] Total yield for all states

[o] Total acres for all states * Does not include BWE cost

Table 2. Recommended additions of insecticides and miticides for use on cotton pests for the 1986 crop year

State	Product	lb. (AI)/acre	Target Pest(s)
Alabama	Scout®	0.015-0.019	bollworms
	Larvin®	0.6-0.9	bollworms, fall armyworm cabbage looper
	Penncap-M®	0.25	diapausing boll weevil
	Pydrin®	0.05-0.2	cutworms
	Curacron®	0.5-0.75	spider mites
Arkansas	Larvin®	0.6-0.9	bollworms
	Scout®	0.015-0.019	bollworms
	Bolstar®	0.25	plant bugs
	Curacron®	0.75	spider mites
	Ambush®, Pounce®	0.1-0.2	cutworms
	Curacron®	0.75-1.0	armyworms
	Bolstar®	0.75-1.5	armyworms
	Larvin®	0.6	armyworms
Georgia	Karate®	0.2-0.35	Helliothis, boll weevil
	TD 2184	0.25-0.75	Heliothis eggs
	UC 80502	8-16 oz/cwt sd tmt	thrips
	Aastar	3-5	thrips
	SD 70616	0.0125-0.0375	Heliothis, boll weevil
	SD 7990	0.0125-0.0375	Heliothis, boll weevil
Louisiana	Larvin®	0.6-0.9	bollworms, arymworms, loopers
	Scout®	0.015-0.019	bollworms, loopers
	Monitor®	0.1-0.2	thrips
	Cypermethrin	0.025	cutworms
	Lorsban®	0.187-0.25	plant bugs, aphids
	dimethoate	0.15	thrips
	Orthene®	0.15-0.2	thrips
	Penncap-M®	0.25	boll weevil
	Cymbush®, Ammo®	0.05-0.06	bollworms
Mississippi	Scout®	0.015-0.019	bollworms
	Larvin®	0.6-0.9	bollworms, beet and fall armyworm
	Curacron®	0.75	aphids, spider mites
New Mexico	Cymbush®, Ammo®	0.04-0.1	bollworms, cutworms
	Larvin®	0.6-0.9	cutworms, bollworms, beet armyworm, cabbage looper, fleahopper, cotton leafworm
N. Carolina	Scout®	0.019	bollworm
	Larvin®	0.6	bollworm
	Orthene®	0.25	thrips
Oklahoma	Azodrin®	0.1	cotton fleahopper, thrips
	Vydate®	0.25	fleahopper, boll weevil
	Guthion®	0.25 ULV	deleted (boll weevil)
	Larvin®	0.6-0.9	bollworms, beet armyworm
	Scout®	0.015-0.019	bollworms
	malathion	0.58	grasshoppers
	Lorsban®	0.5	deleted (spider mites)
	Kelthane®	1.0-2.0	spider mites
Oklahoma	Azodrin®	0.1	cotton fleahopper, thrips
	Vydate®	0.25	fleahopper, boll weevil
	Guthion®	0.25 ULV	deleted (boll weevil)
	Larvin®	0.6-0.9	bollworms, beet armyworm
	Scout®	0.015-0.019	bollworms
	malathion	0.58	grasshoppers
	Lorsban®	0.5	deleted (spider mites)
	Kelthane®	1.0-2.0	spider mites
S. Carolina	Larvin®	0.6-0.9	bollworms, beet and fall armyworm
	Scout®	0.015-0.019	bollworms
Tennessee	methyl parathion	0.5	stink bugs
	Guthion®	0.5	stink bugs
Texas	Larvin®	0.6-0.9	bollworms
	Scout®	0.015-0.019	bollworms

Table 3. Promising experimental insecticides evaluated in small plot and field tests.

State	Compound	lb. (AI)/acre	Target Pest(s)
Alabama	PP-321 (Karate®)	0.015 & 0.02	boll weevils, thrips
	FMC-54800 (Capture®)	0.015 & 0.06	spider mites, thrips
	MK-936 (avermectin)	0.01	spider mites
	Bay FCR 1271 (Baythroid®)	0.025-0.028	bollworms, boll weevils
California	ABG 6162A (thuringiensin)	0.01 & 0.13	spider mites
	bisclofentezin (Apollo®)	0.25 & 0.5	spider mites
	DPX Y5893 (hexythiazox)	0.12 & 0.25	spider mites
	MK-936 (avermectin)	0.01	spider mites
Louisiana	MO-79900 (Asana®)	0.25-0.3	boll weevils, bollworms
Mississippi	TD-2184	0.25, 0.5, 1.0	bollworms, boll weevils
	MO-79900 (Asana®)	0.025	bollworms
	MAT-5927	0.44 & 0.55	aphids
	CGA-112913 (substituted urea IGR)	0.1	bollworms
	BAY FCR 1271 (Baythroid®)	0.022	bollworms
New Mexico	MO-79900 (Asana®)	0.031	aphids, cotton fleahoppers, bollworms
	FMC-54800 (Capture®)	0.04	thrips, cotton fleahoppers, bollworms
	thiodicarb (Larvin®)	0.6-0.9	cotton fleahoppers, bollworms
	Bay FCR 1271 (Baythroid®)	0.033	thrips, cotton fleahoppers, bollworms
	PP-321 (Karate®)	0.015, 0.02, 0.025, 0.03	thrips, cotton fleahoppers, bollworms
	beta exotoxin	0.066, 0.13	thrips, fleahoppers
	fluvalinate (Mavrik®)	0.06-0.075	bollworms
N. Carolina	Capture®	0.06	European corn borers
	Larvin®	0.6	European corn borers
Oklahoma	MO-79900 (Asana®)	0.0125 & 0.025	bollworms
	PP-321 (Karate®)	0.015, 0.02, 0.025	bollworms
Texas	FMC-54800 (Capture®)	0.05	bollworms, aphids
	MO-79900 (Asana®)	0.031	bollworms
	PP-321 (Karate®)	0.025	bollworms, fleahoppers
	MK-936 (avermectin)	0.01 & 0.02	cotton fleahoppers, spider mites
	thiodicarb (Larvin®)	0.125-0.45	fleahoppers
	fonofos (Dyfonate®)	0.5	aphids, fleahoppers
	(Aim)	0.06	tarnished plant bugs
	ABS 6132	0.066 & 0.13	spider mites

PRODUCTION PRACTICES: EFFECTS ON COTTON INSECT PEST POPULATIONS

J. R. Bradley, Jr. and A. M. Agnello
Professor and Research Associate
North Carolina State University
Department of Entomology
Raleigh, NC 27695-7630

Abstract

Cultural practices for cotton insect pest control were severely reduced with the introduction and success of new synthetic insecticides after World War II. This led to a crisis in the 1950's that forced a reassessment of production philosophies and encouraged re-incorporating the older management practices. Successful pink bollworm control in Texas concentrates on cultural tactics to reduce the susceptible overwintering larvae. Similarly, early harvest and stalk disposal is advocated for boll weevil control, and Heliothis spp. populations can often be reduced by use of fast fruiting, short season varieties with proper planting dates, plant population, and irrigation programs.

Key Words: Boll weevil, Cultural practices, Heliothis, irrigation, Pest management, Pink bollworm, Planting date, Short season cotton

The twentieth century has seen technological development advances perhaps comparable to the entire previous history of mankind. Agricultural productivity in the United States is a splendid example; we have progressed from a subsistence agricultural system to a system so productive that it appears to be on the brink of self-destruction. We simply can not control production sufficiently to insure adequate consumer demand. With all major commodities, supplies are overrunning demand and market prices have fallen below minimums necessary to keep many people in business. The precipitous drop in farm land values in this country is evidence of the crisis.

Despite the overall ill health of the farming industry, there are some farmers who continue to make profits, albeit smaller than desirable and perhaps not comparable to other investment opportunities. Such farmers usually have land with high productivity potential, they possess the desired management skills, and are expert decision makers. These are the farmers who survive crisis periods that always have and will continue to make farming a high risk occupation. Successful farmers are adaptive to changing technologies and responsive to new strategies developed for use of the new technology. Usually new technology is adopted without adequate knowledge of the long term effects, both beneficial and detrimental, because experimentation in time and place has been inadequate to be predictive. As a result, philosophy regarding the proper use of technology is an evolutionary process to which farmers must be reactive.

A prime example of the introduction of new technology and changing philosophy toward its optimum

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